SYLLABUS

Title:	**Nanotechnology in Space Engineering**		
Degree of study:	II (Master), III (PhD)		
Field of study, specialty:	Any engineering specialty		
Code:		**Semester:**	**Number of ECTS: 3**
Level of the subject: intermediate		**Type of the subject:** elective	
Hours: 60 h	Lectures: 20 h Practice: 0 h Labs: 15 h Consultations: 10 h	Individual work: 15 h	
Responsible for the subject:	dr hab. Natalia Kizilova		

Objectives of the course

C1. Teaching the basics of nanomechanics, nanofluidics and nanotribology.
C2. Acquainting with micro / nano-structured materials for aviation engineering.
C3. Acquaintance with space satellites and principles of motion: from macro to nano-avionics.

Prerequisites for knowledge, skills and other competences

1. Basic knowledge of theoretical mechanics, mechanics of deformable solids, fluid mechanics.
2. Basic knowledge: aerodynamics, space engineering, propulsion principles.

Learning outcomes (knowledge)

EW1 - The student understands the basics and equations of nanomechanics of deformable solids.
EW2- The student understands the basics and equations of micro / nanofluidics.
EW3 - The student understands the basics and equations of micro / nanotribology.
EW4- The student distinguishes the principles of propulsion, movement and resistance of drones, space satellites.
EW5- The student knows the basic concepts and laws for nanofluidic devices.

Learning outcomes (skills)

EU1 - The student is able to solve the problems of micro / nanomechanics of deformable solids in space engineering.
EU2- The student is able to solve the problems of the mechanics of micro / nanoliquids in space engineering.
EU3- The student is able to solve the problems of motion, resistance and control in space engineering.
EU4- The student is able to construct micro / nano-structured materials for aviation engineering.
EU5- The student is able to solve the problems of micro / nano thermomechanics in space engineering.

Course content

Lectures	**Number of hours**
Fundamentals of nanomechanics, nanofluidics and nanotribology	4
Autonomous flight systems and underwater systems: principles, types and experimental data	2
Spacecraft and propulsion principles: from macro to nano-avionics (PocketQubes, Sun Cubes, TubeSats)	2
Nanostructured materials for aerospace engineering	2
Nano-scale motors, controllers, heat / mass exchange systems	2
Nanofluidic devices for sample handling, flow control and analysis	2
Large constellations of nanosatellites: problems and immediate prospects	1
Laboratories	
Solving the problems of micro / nanomechanics of deformable solids	2
Solving the problems of micro / nanofluid mechanics	4

Solving the problems of micro / nanoavionics aerodynamics	4
Solving the problems of micro / nanotribology	1
Construction of nanostructured materials for aerospace engineering	1
Solving the problems of micro / nano thermomechanics	3

Basic and supplementary literature

1. Publicly accessible teaching materials.
2. Materials on the website of the faculty prepared by the teacher.

Student's workload

Form of activity	**Average numer of hours**
Contact hours with the teacher (classes)	30
Contact hours with the teacher (consultations)	10
Homework – projects	10
SUM	**50**

Teaching tools

1. Lectures in the form of presentations in PDF format.
2. The content of the lectures and laboratory tasks in the form of files (PDF).
3. Individualized calculation projects for independent solution.
4. Access to the website of the subject, the repository of the subject on the GitHub portal and laboratory instructions.

Assessment methods (F - forming, P - summative)

Fd1-Fd2 - grades from homework,

Fl1-Fl5 - grades from laboratory exercises,

Fl - evaluation from the laboratory test,

Work during laboratory classes and individual or group project presented during classes are assessed.

Details of the grading system published on the course website.

Realization of learning outcomes

Learning outcome	**Effects defined for the whole program**	**Objectives of the course**	**Teaching tools**	**Estimation method**
EW1		C1,C2	Lecture, independent work in laboratories and project preparation	Mark 2-5 or a descriptive estimation
EW2		C3		As above
EW3		C2,C3		As above
EW4		C1,C2,C3		As above
EU1		C1,C3		As above
EU2		C1,C2		As above
EU3		C2,C3		As above
EU4		C1,C2		As above